# A HISTORICAL AND CRITICAL STUDY TO DETERMINE THE FEASIBILITY OF EXPANDED USE OF AUTOMATED INSTRUCTION IN THE NAVAL TRAINING SITUATION

HENRY M. BERRY

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by

Henry M. Berry

Commander, United States Navy

Submitted in partial fulfillment of
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## ABSTRACT

The study traces the history of automated instruction in a civilian environment from its inception in 1926 until it burst up on the American education scene in 1960. It then traces its development in the military environment from 1960 until the present. The study shows that automated instruction was used in a wide variety of educational situations and on a large scale, in civilian as well as military education. Further, it shows that the state of the art had not sufficiently advanced to warrant such action. This is made amply clear by the failures of the armed forces to teach relatively complex subject material. Selected studies are presented to show that these failures resulted from deficiencies in training, technology and programming and to show that in certain training situations automated instruction can be a useful and productive tool.

TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

# CHAPTER I

## THE PROBLEM AND DEFINITION OF TERMS USED

The rapid growth of technology since World War II has resulted in the development and production of weapons systems for use in the U. S. Navy which are of unbelievable complexity. This complexity of weapons systems has generated an unprecented need for highly trained and technically competent personnel. To date the Navy has been reasonably successful in its training effort using conventional instructor-student techniques. However, this success is threatened by several major problems. These are:

Cost of Training. Naval training is expensive. It is costly first of all because of the complexity and diversity of the jobs involved and because of the large numbers of personnel who must be trained. In the fiscal year 1963, for example, the Bureau of Naval Personnel sponsored training for over one hundred thousand men in many hundreds of different formal and specific courses at a total outlay of over seven hundred millions of dollars.[1] But training is expensive for another reason. It is expensive because there is so little time to amortize the cost of training. A majority of personnel given specialized training are available for only a single enlistment, usually four years.

Individual Differences. Individual differences in ability to profit from instruction have always been a perplexing problem in education by anything but a tutorial system. In Naval training there is a problem of almost equal magnitude in spite of selection standards and aptitude testing. This

[1]Statement by VADM B. J. Semmes, Jr. Chief, Bureau of Naval Personnel at a Bureau of Naval Personnel Leadership Field Team Seminar, Washington, D. C., May 16, 1964.

problem is accentuated by the requirement for extremely rapid training of large numbers of trainees.[2]

Quality Control. Naval training requires rigid quality control of the products of training. Normally the only purpose of military training is to develop specific human performance required in various military jobs.

Shortage of Instructors. The shortage of competent instructors is one of the most serious problems in Naval training. The etiology of this problem is complex involving administrative factors and Naval tradition, as well as aptitudes of available personnel. It is a source of serious difficulty in most attempts to increase the effectiveness of Naval training.

It is maintained that judicious use of automated instructional devices can make a worthwhile contribution toward solving these problems.

## THE PROBLEM

Statement of the Problem. It was the purpose of this study to research historical and empirical data relative to automated instruction to (1) determine the state of the art (2) determine those areas of Naval training which have benefited from use of automated instruction and (3) determine those areas of Naval training in which use of automated instruction would be feasible and desirable.

## DEFINITION OF TERMS

Automated Instruction. Automated instruction was interpreted to mean the educational material presented to the learner and includes the device

[2]Gordon H. Eckstrand, Marty R. Rockway, Felix F. Kipstein, Ross L. Morgan, Teaching Machines in the Modern Military Organization, Behavioral Sciences Laboratory, Aerospace Medical Division, Air Research and Development Command, United States Air Force, (Wright-Patterson Air Force Base, Ohio, 1960) P. 3.

used to preset the material such as scrambled book, modified notebook, or any mechanical device.

Program. A program was interpreted to mean a set of materials on a given subject which is to be presented to the learner.

Set. A set was interpreted to mean a portion of the total subject matter (program) which is presented in some predetermined manner. This is the material presented at each learning session.

Frame. A frame was interpreted to mean material presented at any given moment. It is a portion of a set.

Panel. A panel was interpreted to mean material, usually in the form of a graph or text passage which is accessable to the learner during work on a set.

## CHAPTER II

## REVIEW OF THE LITERATURE

### Teaching Machines: 1924 - 1960

The concept of automated instruction was first introduced by Pressey[1] in a paper published in 1926. It was here he advanced his first "testing apparatus" and concluded that it could also be used to teach informational and drill material more efficiently, in certain respects, than the "human machine."

Pressey followed his original paper with another in 1927 and yet another in 1932. Both of these papers presented variations of his original "testing apparatus" but in a more sophisticated form. Not much in the way of further research and development was accomplished except for an experiment conducted by Little at the University of Wisconsin in 1934. Essentially his device was nothing more than an improved version of the Pressey device and did little except to reinforce Pressey's claim that it could be useful in teaching. After 1934 no further experimental work was done and automated instructional devices dropped from view. This temporary demise as viewed by Skinner[2] was due

> ...in part to cultrual inertia; the world of education was not ready for them. But they also had limitations which probably contributed to their failure. Pressey was working against a background of psychological theory which had not come to grips with the learning process.

Psychologists, commencing with E. L. Thorndike and E. C. Tolman (1932), E. R. Gutherie (1935) and C. L. Hull (1943) proposed new theories of learning

[1] S. L. Pressey "A Simple Apparatus Which Gives Test and Scores -- and Teaches," School and Society, XXIII (March 1926), PP. 35-41.

[2] B. F. Skinner, "Teaching Machines," SCIENCE, 128:969, October, 1958.

which included among them immediate knowledge of tests as an important factor. These theories rekindled interest in automated instructional devices. However, it was not until 1954, when B. F. Skinner published his paper "The Science of Learning and the Art Of Teaching," that psychologists began to evaluate automated instruction in the light of prevailing learning theory.

The research effort energy expended through 1959 is shown in figure 1.

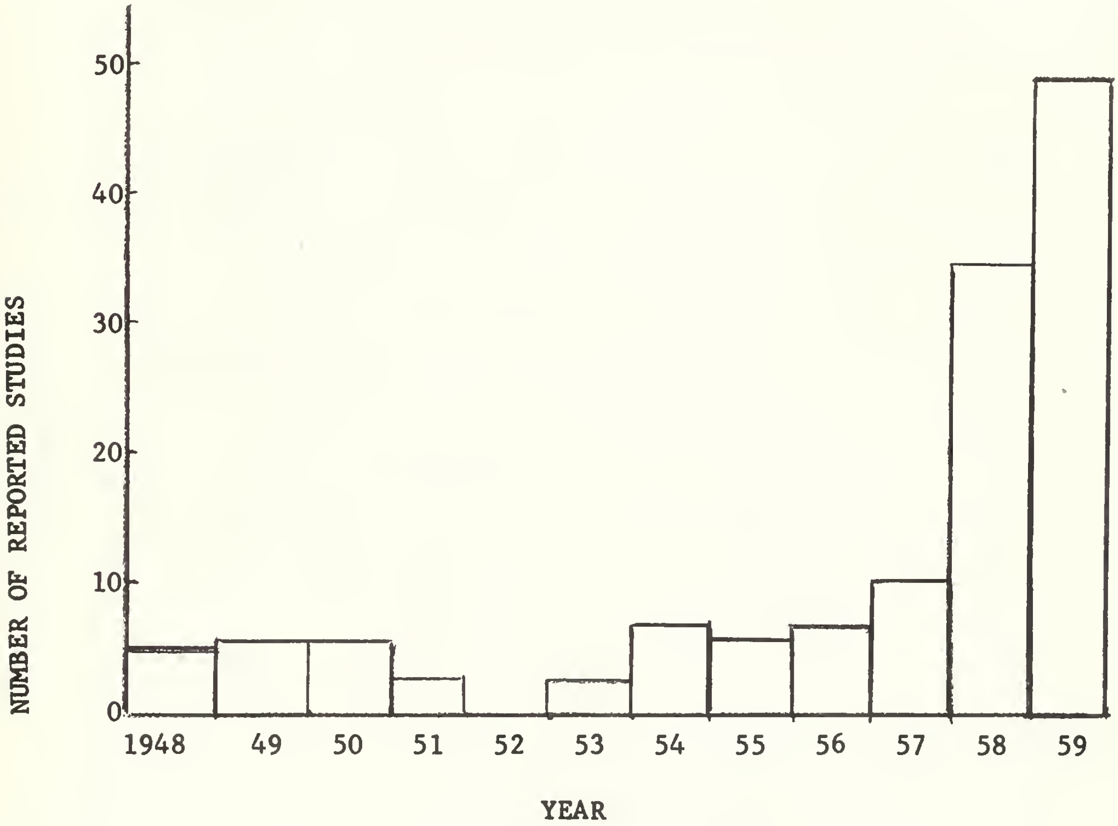


Figure 1. The Frequency Per Year of Teaching Machine Studies, From 1948 to September 1959. There Were 6 References Prior to 1948.[3]

[3] Edward B. Fry, Glenn L. Bryan, Joseph W. Rigney, Teaching Machines: An Annotated Bibliography, Technical Report No. 28, Prepared for Personnel and Training Branch, Office of Naval Research, (Department of Psychology, University of Southern California), P.2.

The majority of the work done at the beginning of the "golden era" of automated instruction was primarily theoretical and dealt with automated instructional devices and their applicability with respect to the relatively new learning theory.

A graphical presentation of the categories of studies is shown in figure 2.

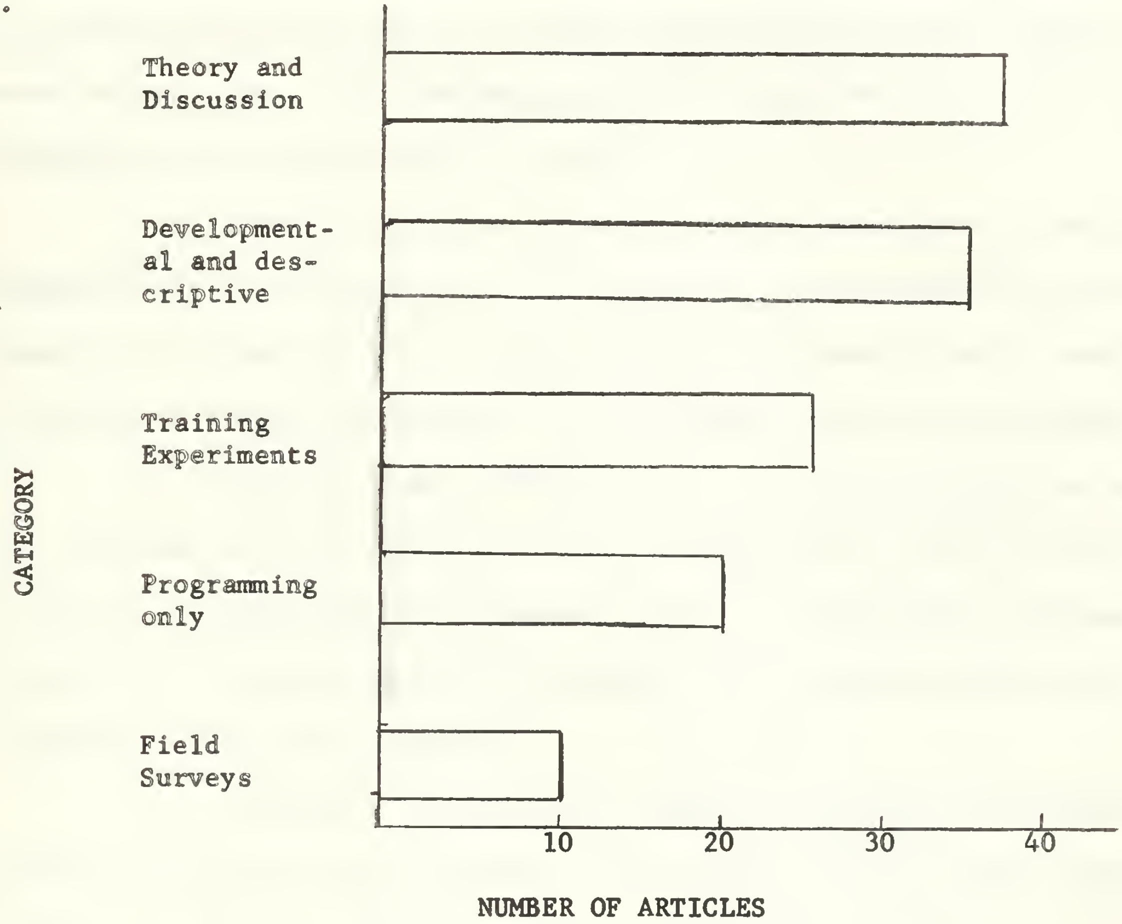


Figure 2. Frequency of Different Categories of Articles Published Between 1948 and 1960.[4]

[4]Edward B. Fry, Glenn L. Bryan, Joseph W. Rigney, Teaching Machines: An Annotated Bibliography, Technical Report No. 28, Prepared for Personnel and Training Branch, Office of Naval Research, (Department of Psychology, University of Southern California), P. 2.

Information gleaned from the studies conducted led to the general conclusion that certain parameters influenced the effectiveness of automated instructional devices. These are (1) characteristics of the device, (2) characteristics of the program and (3) characteristics of the learner. These parameters will be discussed in turn. But first it will be appropriate to enumerate the principles of learning which automated instructional devices were trying to meet. The following principles have been stated in a fine treatment of the subject by W. J. Carr:[5]

1. Learning takes place most rapidly if the student is actively engaged with the subject matter. In essence, this corresponds to the archaic bromide, "you learn by doing." More precisely, learning is not a passive phenomenon but something enhanced only by practice and self-involvement.

2. Learning is most effective if the student develops the skills and knowledge in a form which will readily generalize to the "real life" situation for which they are intended. This is a restatement of Skinner's position that learning demands the composition of responses and not just recognition of correct responses.

3. Learning takes place most rapidly if immediate "knowledge of results" is given for each response. The student can more easily abandon erroneous responses when he can easily relate them to the stimuli with which they are associated.

4. Learning takes place most rapidly if the subject matter is arranged in hiearchic form. On a purely "common sense" basis it is obvious

[5]W. J. Carr, "A Review of the Literature of Certain Aspects of Automated Instruction" (Written at Bucknell University, Unpublished report, Department of Education, January 1959), PP. 4-5.

that fundamentals must serve as the foundation for the learning of more complex relationships. Also motivation and joy in the learning process are better preserved when the student is aware of continuous and unimpeded progress.

5. Receiving frequent "knowledge of results" keeps students working at the assigned task. This is nothing more than presenting the challenge to the student and "making his successes frequent." This raises the overall level of aspiration and provides needed direction.

6. Since learning takes place in individuals, the learning situation should be so designed that each student may proceed at his own pace.

Characteristics of the Device

For the purpose of discussion an automated instructional device may be thought of as having four major components: (1) a display, which presents the program; (2) a response panel, which the learner used in forming his response; (3) a confirming mechanism, which provides the learner with information as to the correctness of his response; and (4) a reinforcement mechanism, which provides the impetus for further operation of the device.

Up to and including 1959 twenty-six devices were studied. While all devices contained the four major component requirements some proved more utile than others. Those which proved more popular than others, for whatever reasons, have become the standards and are discussed below.

Cardboard Mask. This device used by Ferster is perhaps the simplest teaching machine. It is merely a cardboard folder containing a mimeographed sheet, which permits one line of test to be exposed as the mimeographed sheet is moved upwards. For example, when used in teaching a

language, the first line exposed is in English; the student responds on a separate sheet of paper in the language under study, then moves the paper within the mark up one line, thereby exposing the answer. He compares the answer he writes on the separate sheet with the answer in the machine. If this is correct, he marks an X on the margin of the drill paper within the machine. If incorrect, he marks a zero. He works through the drill until he makes two correct responses to each item.

Computers. An IBM 650 digital computer was used by Rath, Anderson and Brainard, (1958), as a teaching machine. Input-output was via means of a typewriter. Knowledge of results was given by having the typewriter keyboard freeze if an error was made.

Programmed Text. This device developed by Homme, Glaser and Evans, is a unique form of textbook. The top third, or panel, on a page represents a question. The student responds to the question subjectively and then turns the page to learn the next question on the top panel continuing as before. After the student has worked through the top panels, he returns to the front of the book and works through the middle panel; then the loser panel.[6]

Punchboard. The punchboard was developed by Pressey at Ohio University. It is a small board about the size of a man's hand, which contains rows of holes. Multiple-choice questions are presented on a separate mimeographed sheet, and the students respond to each question by punching a hole in the appropriate row. If his choice is correct, the pencil goes deep into the punchboard; if he is wrong, the pencil does not go so deep. Each punch, correct or incorrect, makes a hole in the paper which can be preserved.

[6] R. Glaser, L. E. Homme, J. L. Evans, "An Evaluation of Textbooks in Terms of Learning Principles" (Paper read at the meeting of the American Education Research Association, Atlantic City, N. J., February, 1959).

_Scrambled Book_. The scrambled book presents a problem situation on the first page with several multiple-choice answers at the bottom which gives a page number. The student then turns to this page and is told whether or not his selection is correct and why. The device provides "branching" which means the students making incorrect answers are given help or led to repeat a certain section of the main program. This device was developed by Crowder in 1958.[7]

_Trainer-Tester_. The trainer-tester usually presents a multi-stage problem on a printed sheet of paper. Responses are made by erasing a silver overlay revealing the answer below. The results of one step frequently give the student knowledge so that he can proceed to the next. This device is usually used in conjunction with diagrams in trouble shooting problems. This device was developed by the U. S. Navy, Special Devices Center, Port Washington, N. Y.

Experimental studies in 1954-1960 confirmed that these devices do conform to the criteria for learning. Controversy had arisen as to which device was the "best" but, as with many other facets of human behavior, there did not appear to be any "best" device. Rather it would seem to depend upon many variables present in a particular situation as to which was the "best" device to use.

## Characteristics of the Program

_Principles of Programming_. Programming refers to the arrangement of materials to be learned in the order of presentation which will tend to maximize the rate of acquisition and retention.

[7] Norman A. Crowder, _An Automatic Tutoring Book on Number Systems_, Volume I (Timonium, Maryland, Hoover Electronics Company, 1958) PP.4-47.

The following principles of programming have been abstracted from the works of various authorities by O. Robinson and J. Siegel.[8] In effect, these guiding principles have a rather secure status despite the limited direct experimentation. Most of them are based on well established principles which have evolved from the laboratory study of behavior.

1. The amount of work necessary to procure a reinforcement is to be kept low since motivation decreases as the work necessary for reward increases.

2. Where new material is presented, several illustrations should be provided so that the effects of practice can be maximized.

3. Material that is well understood should not be repeated. Repetition, when unnecessary, is tedious. In other words, over-learning is to be controlled in keeping with Principle 1.

4. Complex conceptual material should be approached in a step by step fashion. Thus, the learner is non-verbally aware of the concept before it is presented in its entirety. These steps should be determined in such a way that when summated will comprise the desired behavior.

5. The programmer is to have a complete knowledge of the terminal Stimuli-Response (S-R) connections he is trying to establish in the learner. These have been referred to as the "behavioral end-products" of the program.

6. In the interest of parsimony, the programmer must be aware of the initial S-R connections in the learner's intellecutal repertoire. In this way the efficient program is one that takes advantage of the knowledge the learner brings into the learning situation. It is to be kept in mind that if anything, the programmer should tend to underestimate the learner's

[8] O. Robinson and J. Siegel, Automated Teaching: History, Principles and Applications (New York, Columbia University Press), PP. 11-13.

initial level of competence; i.e., he should assume, when in doubt, the learner is only partially or not at all aware of the material being presented.

7. Behavior that is learned must be repeated to be maintained. Recycling must be provided if the error level is to be kept low over long periods of time. However, this should be established within the framework of principle choice.

8. After all of the terminal S-R connections have been learned these concepts should be incorporated into a problem which will essentially constitute a review.

9. As the program progresses present material should be meaningfully connected to preceding material such that efficient response chains will be established.

<u>Program Characteristics</u>

A distinction should be drawn between programming principles and programming characteristics. The principles of programming enumerated above might be received as law-type statements since they have evolved not so much from automated teaching research as they have from a plethora of experimental analysis of behavior. The characteristics of a program are more specific than the guiding principles and are far more the result of research specifically in the field of automated teaching. Much of the theory of program characteristics is attributable to the work of Skinner and is generally accepted. However, in certain respects Crowder disagrees with Skinner and as a result two schools of thought have developed with respect to programming. This dichotomy will be discussed later. The following characteristics are generally accepted by both Skinnerian and Crowderian programmers:

<u>Length of Program</u>. The length of the program is determined by the material to be covered and the number of hours the learner has available. The

programmer, therefore, must know what the course aims are; i.e., what the terminal S-R connections are to be. These must be compatible with the students schedule.[9]

Length of Set. A set of approximately thirty frames would seem to provide sufficient material for the rapid learner and not exact excessive burdens on the slow learner.[10]

Length of Frame. The frame should not be so long that the learner is encouraged to skim the material and go directly to the blank. Material extraneous to the central point should be avoided. Naturally, illustrative material is not to be considered extraneous.[11] It is sometimes desirable to present a considerable amount of text before asking the student to respond. However, if material is long, care must be taken to insure that terms and materials throughout the test are relevent to the right answer.[12]

Number of Blanks. In order not to weaken the syntactical structure of the material, it is advisable to use only one blank per frame where possible. However, requiring synonymous forms of the answer is alright.[13]

[9] B. F. Skinner and J. G. Holland, "The Use of Teaching Machines in College Instruction," A. Lumedaine and R. Glaser, Teaching Machines and Programmed Learning (Washington, D. C. : National Education Association, 1960), PP. 159-172.

[10] Ibid., PP. 159-172.

[11] Ibid., PP. 159-172.

[12] J. Beck, "On Some Methods of Programming," E. Galenter, Automated Teaching: The State of the Art (New York: John Wiley and Sons, Inc., 1959), PP. 55-63.

[13] B. F. Skinner, "Principle Features of a Useful Teaching Machine," D. Robinson and J. Seigel, Automated Teaching: History, Principles and Applications (New York: Columbia University Press, 1960), P. 14.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

There are occasions when two or more items can be printed in a given frame and separate answers required. Multiple-blank items permit the student to organize material in a more coherent manner.[14] The seeming conflict posed by these two statements is a specious one. Multiple-blanks can be used to integrate meaningful elements but should not be used for the sole purpose of getting more information into each frame.

Lead Ins. The program should take advantage of the common knowledge of subjects and should employ phrases with high association value.[15]

Indicate Catagories. Questions appearing in the program should be stated in such a way as to limit the number of answers possible.

Underlining and Capitalization. Aside from indicating categories and providing lead-ins, the program should also make use of underlining and/or capitalizing those terms which are most significant. Copying such items is another good prompt since it insures that the item has been seen.[16]

Explanation. Programmed material must be explanatory and not just guiding. In other words, the learner is to be given insight into why the material is correct rather than just directed to know what is correct. Studies weighing the relative efficacy of guidance and explanations find explanations vastly superior to guidance.[17]

Knowledge of Results. All programs must be designed to provide the

[14] B. F. Skinner and J. G. Holland, loc.cit.

[15] B. F. Skinner and J. G. Holland, loc.cit.

[16] S. R. Meyer, "Report on the Initial Test of a Junior High School Vocabulary Program," A. Lumsdaine and R. Glaser, Teaching Machines and Programmed Learning (Washington, D. C. : National Education Association, 1960), PP. 229-246.

[17] J. G. Holland, "Teaching Psychology by a Teaching Machine Program," O. Robinson and J. Siegel, Automated Teaching: History, Principles and Applications (New York: Columbia University Press, 1960), P. 15.

learner with information concerning the correctness of his response. He can be told that he is right or wrong, what the correct answer is, why he was wrong, or all of these. It should be kept in mind however, that errors are reduced and learning is more efficient the more immediate and more specific is knowledge of results.

Errors. The programmer must look upon numerous errors more as a function of his programming deficiencies than the learning deficiencies of his students. When errors are frequent, revisions are necessary.

In 1958 a major dichotomy occurred in the ranks of the proponents of automated teaching techniques. This schism occurred with respect to programming techniques of which two are commonly recognized. These techniques are linear and branching programming and their differences are briefly discussed below.

Linear programming, developed by B. F. Skinner, features immediate reinforcement in learning. The programming steps are very short, often requiring the student to read twenty-five words or less. The student receives reinforcement as well as stimulation by successful completion of each step. The program is based on "errorless" learning, that is, continuous success within reasonable bounds. If as many as 5% of the students make an unplanned response at some point in the program, then a revision is necessary. This technique provides a continuous "straight line" or linear path to the learning objective.

Branching programming, also called intrinsic, was developed by Crowder. It uses responses to establish routes of learning. The steps often exceed a half page in length. The philosophy applied is that of communication. The element of choice is used to provide "feed-back" to the student as to whether or not he understands the material presented and can continue on the "straight

line" or linear portion of the program. When an incorrect choice is made the student is branched, or sent by another route of learning which involves review and remedial steps leading back to the main portion of the program.

It is to be noted that both techniques conform to the principles and characteristics of accepted programming. Their essential difference is in the method or device used in presenting the material to be learned.

Characteristics of the Learner

The third major variable of which the effectiveness of automated instruction is a function has to do with the characteristics of the learner. The concept of individual differences has been implicit throughout the preceding discussion of the variables which influence the efficiency of a program to be used for automated teaching of a given subject. For example, the kind and number of initial S-R connections available to the programmer for use as starting points for the program will obviously depend on the learner's previous reinforcement history. Moreover, the learner's intelligence and his aptitudes and interests with respect to the subject matter being taught might influence the characteristics of the program having to do with repetition, sequencing and stepping. Prior to 1960 comparatively little research was done with respect to this most complex of variables affecting the efficiency of automated instruction. It may be that this failure has been largely responsible for automated instruction not being as efficient as it might otherwise have been.

This section has followed the development of automated instructional devices from their inception in 1926 to the threshold of their appearances on the American educational scene in 1960. During this period more precise

principles of learning were developed. These came from careful work done in the laboratory. Convinced that other than conventional teaching techniques were more efficient, researchers developed automated teaching devices and devised programming principles and characteristics from careful research which, under carefully controlled circumstances, were more efficient. However, it is to be noted that these developers were experts in the field of psychology and in learning theory and the programs developed were in the relatively sterile environment of the classical educational situation and in disciplines with which they were intimately familiar. Nevertheless, eager to exploit this "breakthrough" in education some students of this new concept began to develop programs for use in every day training situations. A resumé of these programs as of the beginning of 1960 is shown in Table I.

Table I

Teaching Machine Programs Developed for Experimental Studies Prior to September 1959

| Principal Investigator or Author | Date | Institution | Subject | Level |
|---|---|---|---|---|
| Pressey (et al) | 1950 | Ohio State U. | Educational Psychology | College |
| Skinner (Holland) | 1958 | Harvard U. | Psychology | College |
| Porter | 1958 | Harvard U. | Spelling | 2nd & 6th grades |
| Meyer | 1958 | Harvard U. | Arithmetic | Elementary |
| Gilbert | 1955 | U. of Georgia | Algebra | College (?) |
| Evans | 1958 | U. of Pittsburgh | Number bases | College |
| Crowder | 1958 | Western Design | Number systems, Bridge | Adult |
| Trainer-Tester | 1954 | Navy (SDC) | Electronics trouble shooting | Adult |
| Bryan | 1958 | U. of So. California | Electronics trouble shooting | Adult |
| Smith | 1958 | U. of Michigan | Grammar | High School |
| Schutz | 1958 | U. of Arizona | Arithmetic | Elementary |

Teaching Machines: 1960 - 1965 - The Industry

A number of factors combined to give impetus to the acceptance of automated instruction. This acceptance by an educational system not prone to change was indeed phenomonal! However, if one considers the factors involved it would appear there was no feasible alternatives open to educators.

First, the educational system was faced with an acute shortage of teachers; a shortage which was not likely to be overcome in the foreseeable future. Second, the "War babies" from WW II were reaching secondary and college level school age and facilities were not adequate to accommodate this sudden increase in students. Last but not least was the impact the Russian advances in space technology had upon the philosophy of the educational system. Faced with these problems it is no wonder that educators turned to automated instruction as a possible solution.

Except for experimental studies in teaching Psychology, at Harvard by Skinner and Holland, little had been done in practical applications of automated instruction. However, in 1960 this was radically changed by an experiment conducted by Dr. Allen Calvin of Hollins College in the Roanoke, Virginia public school system. In the Roanoke experiment thirty-four eighth-grade students completed a one year course in ninth-grade algebra in one-half the normal time. The course consisted of algebra, geometry, trigonometry and an introduction to college algebra and calculus. On a national achievement test, 41% of the students obtained scores at the ninth-grade level. In March 1961, twenty-five of the original students were tested and averaged better than 90% of their first scores.[18]

[18] Wilbur L. Ross, Jr., and others, Teaching Machines: Industry Survey and Buyer's Guide (New York: The Center for Programmed Instruction, Inc., 1962), P. 42.

This experiment and its extant publicity so impressed the management of Encyclopedia Brittannica Films that they invested one hundred thousand dollars in a programming center at Hollins College.

At about the same time that Encyclopedia Brittannica Films made automated instruction a commercial venture, Teaching Machines, Inc. was formed in Alberquerque, New Mexico by the eminent psychologists L. E. Homme, L. B. Wyckoff, S. L. Evans and Robert Glaser. Immediately the firm became the leader in the field and remains so today despite the entry of such publishing giants as McGraw-Hill, Prentice-Hall and others. By 1962, the producers of commercial automated instructional devices and programmed materials had grown to thirty-five and by 1964, the latest census, they numbered one hundred and twenty-eight domestic firms and five foreign ones.[19] The programs available in 1964 covered twenty-five major subject areas and innumerable sub-divisions thereof. It is estimated that there are over fifteen hundred programs available covering subjects from grade school through college. The number of frames per program vary from as few as one hundred for simple ones to as many as eighteen thousand for more complex programs such as college level chemistry. The mean number of frames is about seven hundred. As a result of this huge volume of programmed material, and the market competition, programs were and are being produced which are somewhat less than satisfactory. A sample of the numerous programs, the devices required, the programmer, the number of frames per program and cost is shown in Table 2.

[19] Carl H. Hendershot, Programmed Learning: A Bibliography of Programs and Presentation Devices (Saginaw, Michigan: Scher Printing Company, 1964), PP. V - XII.

TRAINING SYSTEMS INCORPORATED

| Title | Author | Level | No. Frames | Cost | Machine or Device |
|---|---|---|---|---|---|
| Gyro Fundamentals | Levine | HS & Coll. | 102 | $ 4.95 | Programmed Text |
| Basic D.C. Circuits | Levine | HS & Coll. | 350 | $ 2.65 | Programmed Text |
| Transistor Fundamentals | Levine | HS & Coll. | 350 | $ 5.95 | Programmed Text |
| Numbering Systems & Binary Arithmetic | Levine | HS & Coll. | 300 | $ 3.95 | Programmed Text |
| TEACHING MATERIALS CORPORATION | | | | | |
| Fundamentals of Algebra | Evans & Yesselman | HS | 1,993 | $11.00 | Min/Max. |
| Descriptive Statistics | Evans & Homme | HS & Coll. | 836 | $ 6.00 | Min/Max. |
| Biology & Chemistry | Jefferies | JHS | 2,113 | $13.50 | Min/Max. |
| Sound, Light, Electricity & Communications | Jefferies | JHS | 1,823 | $13.50 | Min/Max. |
| | | | | Min/Max. costs $25.00 per unit | |

TABLE II

REPRESENTATIVE AUTOMATED TEACHING PROGRAMS AND DEVICE

WITH ASSOCIATED COSTS

Teaching Machines: 1960 - 1965 - The Armed Forces

The Armed Forces were not insensitive to the clamor raised about the "revolutionary teaching devices" and viewed them as a possible solution to some of their training problems. The first major effort was conducted by the U. S. Air Force in 1960 when it contracted for extensive studies with respect to using automated instructional devices and programmed texts in training SAGE operators. When these studies were reported as being favorable, additional studies were contracted for to determine the feasibility of using automated instructional devices to teach "trouble shooting" techniques of electronics systems maintenance. By the end of 1962 thirty-nine studies had been conducted by various researchers and the results reported. In most cases the results were favorable. As a result of these investigations and the findings of the Air Force Path Finder Study Group, which was established in late 1961, the Air Force Air Training Command embarked on a two phase project to incorporate automated instruction into its training environment.[20] Phase I was to be an experimental application of programmed instruction to a hetrogeneous group of courses and Phase II would be an expanded use if the results of Phase I warranted such action. Phase I results were considered acceptable and Phase II has been implemented. At the commencement of Phase II over one hundred programmed instructional packages were in use or under development. As an example of the success of automated instruction, a six-hour block of instruction in "Basic Hydraulic and Pneumatic Principles" was programmed. The resultant course required only one hour on the average for students to complete and at the same time resulted in a gain in performance of 20%. Other results were equally as good

[20] James E. Briggs, Lt. Gen., USAF (Ret.), "Programmed Instruction Breakthrough in Air Force Training??", Trends in Programmed Instruction (Washington, D. C. : National Education Association, 1964), P. 131.

in reduction of time required to complete a course or in increased student performance but are too numerous to mention here.

The U. S. Army was probably the first of the armed services to consider using automated instruction as a possible solution to its training problems. This was due, in part, to the unique character of its Human Resources Research Office (HumRRO) which was established in 1951 on an army wide basis. However, the first evidence of Army interest was a project contracted for in 1961 to explore the feasibility of developing a program of automated instruction. The "in-house" capability of HumRRO provided the Army with investigative personnel to conduct its own research effort and little in the way of data is available concerning the early Army investigations with respect to the adoption of automated instruction. However, HumRRO was busily developing programs for automated instruction and by 1964 roughly one hundred blocks of programmed instruction, from one to forty hours in length, were in use and one hundred and fifty more in various stages of development.[21] The Army embarked on this major program with three goals in mind.

First, the program would be justified only if and to the extent that it effected substantial, demonstrable savings in resources expended -- reduced in-training time of students, reduced requirements for instructor manpower and reduced requirements for training facilities, aids or equipment.

Second, programming efforts would be carried out by Army personnel rather than by outsiders.

Third, as operators and not researchers it was decided to concentrate

[21] Thomas Shaughnessy, "Programmed Instruction in Army Schools" (Paper read at National Society for Programmed Instruction, San Antonio, Texas Convention, April 2, 1964).

on designing programs and putting them to use without worrying about the validity of one or the other schools of thought.

A review of the results of two years effort gave rise to these conclusions:

1. Programs varied widely in quality. Some were as good as could be obtained from any source and some were as bad as any seen on the commercial market.

2. Programmed instruction had not yielded the savings expected and had not nearly paid for itself. However, administrative constraints were deemed responsible for this rather than programmed instruction itself.

The failure of programmed instruction in coming up to expectations prompted a reappraisal of the Army's effort and the next several years should decide whether automated instruction will provide an answer to the training problem. To reach some definitive conclusions the following steps are to be taken:

(1) In-house grass-roots-level programming effort will continue at several schools, though under tightened and substantially raised standards.

(2) An entire course, both academic and practice phases, will be programmed and detailed cost-benefit statistics will be kept in order to determine once and for all if programmed instruction can or cannot produce the substantial net savings which are claimed.

(3) Map reading will be programmed in the hope of saving thousands of instruction preparation man-hours presently wasted in producing a hundred minor variations of the same theme at a hundred training establishments.

(4) Electronic maintenance courses, presently numbering seventy-five, will be programmed - both the academic and practical phases - beginning with the four hundred or so hours that are largely common for all

electronic specialists. It is hoped that the savings that will accrue from bright students completing those four hundred hours in as little as two hundred hours ought to balance the five hundred thousands of dollars the project will ultimately cost. Equally, if not more important, it is hoped that programmed instruction will provide the means to see the less bright student through the course - the means to salvage these men who are reluctantly scrapped after twenty to forty weeks of blood, sweat and tears on his part as well as the Army.

Optimism for the success of this bold effort is due, in a large measure, to a new concept of the technology of training. By this is meant a group of seven steps. These are: (1) Analysis of the operational system and training system; (2) Analysis of the job; (3) Analysis of the tasks to specify required knowledge and skills; (4) Determination of training objectives; (5) Construction of the training program; (6) Development of measures of proficiency; and (7) Evaluation of the training program. Each of these steps is briefly discussed below.

A system is a group of inter-related and inter-communicating components, organized to achieve a goal. Some of the components may be machines, others will be people. Systems also contain rules or policies which affect their operation. They are also embedded in larger systems, which place constraints upon the smaller systems.

The student is a part of the training system. When he graduates he will become a part of the operational system. By analyzing the operational system it is possible to discover the context of the job he is to perform. It is possible to learn the policies which restrict him to the use of certain kinds of tasks, and eliminate the performance of other tasks, which are thought of

as being nice to teach him. His role in contributing to the system is learned. Tasks vital to the mission of the system and less essential tasks are determined. This helps to determine the level of proficiency required.

By analyzing the training system what the student should bring to the course is determined. Also policies which place constraints on the kind of training which can be given are learned.

A job analysis for training must identify all the major duties in the job and the tasks which make up their duties. The physical and environmental conditions of the work must be described. The tools, the test equipment, the job aids and manuals that the worker must use must be specified. The standards must be specified.

The initial step is to analyze each task to be performed in stimulus-response detail. It must be known what must be done, how fast and how accurately. Cues and signals which tell when an action is to be performed must be identified. The action must be described precisely and the feedback which tells whether the action has been performed correctly must be described.

One of the reasons for making a precise description of a task is to identify the kind of symbolic material needed to perform the task. The symbols are usually called knowledge. The precise determination of knowledge is extremely important. One of the most common failings, and greatest wastes in training, is to teach more knowledge than is required. There are large bodies of knowledge, theory and history surrounding nearly every human endeavor. What is useful in one situation may not be in another.

Determination of training objectives is a statement of the behavior that is expected of the student at the end of the course. In selecting this objective the following might be considered:

(1) What does the student already know?

(2) What will the student learn in later courses or on the job?

(3) What job aids are available on the job?

(4) What must the student do immediately on the job vs. what things he can develop on the job?

(5) What behaviors are critical to the performance of the system?

It is obvious that teaching too little can be costly but, just as important, so can too much. Too much teaching requires longer courses, more instructors and more programs. Students may fail irrelevant parts of the course or irrelevant criteria may be used to select students for the course.

Construction of the Program means following the accepted rules for program construction. In addition, it is here that the course objectives should be presented to the students.

When developing the program it will be necessary to develop a performance test to determine that the programs have actually taught the task.

Proficiency tests must be routinely used in order to insure control over the quality of the program. The results must be fed back to the programmer in order that he may make appropriate changes to the program.

The Navy along with the other services recognized that automated instruction might have a bright future in naval training and in 1960 set out to evaluate its possible uses. Originally seven contracts were let for research concerning the devices available and their application to the principles of learning theory. Other contracts were let to research other facets of automated instruction. The results of these studies led the Navy to consider using automated instruction.

In 1961 it was recommended that:[21]

1. Some programmed instruction be used when it best fit the Navy's needs.

2. The Navy should develop its own programmers.

3. All programming techniques should be used.

4. All programs should be field tested and revised prior to publication.

5. Objectives to all training be precisely defined.

In October - November 1962 the first course on Programmed Instruction was conducted at the Fleet Training Center, Newport, R. I. and subsequently a three week programmers course was established at the Service School Command, Great Lakes, Illinois to convene twice annually in January and July.

From the beginning it appears the Navy has been somewhat less than enthusiastic with respect to automated instruction when compared with the U. S. Air Force and Army. However, administrative problems associated with assignment of personnel from "sea duty" to "shore duty" may be in a large part responsible. None the less the Navy, as of October 1964, had only six courses of programmed instruction in use and five programs as supplemental material.[22]

The following summary of Bureau of Naval Personnel Instruction 1500.50B dated 2 November 1964 sets forth the official Navy policy at this time:

...programmed instructional material is beneficial in many cases,

[21] George King, "Report on Institute and Workshop on Programmed Instruction" (Unpublished report, Bureau of Naval Personnel, Washington, D. C., 1961), P. 2.

[22] Special report prepared for the Secretary of the Navy by Chief, Bureau of Naval Personnel, October 1964.

> and advantageous in some cases. Experience has indicated that such material is not a panacea for all training ills. If used on a selected basis for training in specifics, it has merit. It also has value for preparatory and remedial training, supporting established and on going programs.
>
> ...Chief of Naval Personnel will support, within available sources and control an expanded use of programmed instructions in Navy training activities under his cognizance. The extent of this effort will be based on a demonstrable need and anticipated use.
>
> ...the Chief of Naval Personnel will continue to experiment and observe results of programs conducted both within and outside the Navy with a view of adopting productive methodology as it becomes apparent.

In summary, the armed forces have adopted automated instruction in varying degrees and with varying degrees of enthusiasm. The results have been equally varied. The Airforce and Army committed a great deal of time, money and energy to all facets of automated instruction. True the results in many cases were very disappointing, but they both learned much about proper programming and the characteristics of the learner. The Army, in fact, developed an entirely new concept of training which would permit good programming and consequently more productive training. The Navy, for whatever reason, adopted a neutral,if not a negative, policy as indicated above. It would appear that the future of automated instruction will be decided within the next several years.

# CHAPTER III

## REPRESENTATIVE EMPIRICAL STUDIES

Many courses of instruction have been programmed for automated instruction and many claims have been made as to their capability for reducing instruction time, for increasing student learning and for reduced cost in the long run. Studies conducted for and within the Armed Forces have produced various results; some extremely good while others have been somewhat less than heartening. It is the purpose of this chapter to present several representative studies which point up some of the strengths as well as weaknesses in the art and science of automated instruction as it presently exists. Two studies from the Navy and one from the Army and Air Force will be presented as well as one conducted by the Royal Navy of Great Britain. There is no need to present these studies in their entirety. Rather, the general tenor and results of the experiments are considered germaine to this paper and will be presented.

### ROYAL NAVY

An Attempt to Use Automated Instruction in Electrical and Radio Theory for Realistic Technical Training[1]

This study was second in a series designed to determine the feasibility of using automated instructional devices to teach electrical and radio theory. The study was conducted in the HMS COLLINGWOOD and covered the period from January to July 1963.

[1]D. Wallis, An Attempt to Use Automated Instruction in Electrical and Radio Theory for Realistic Technical Training, Senior Psychologists' Division, Manpower Division, Admiralty Center for Scientific Information and Liaison, Royal Navy.

A newly entered class of ratings were divided into four matched groups and one group was given automated instruction while the other three received conventional classroom instruction. A comparison was then made of the results after common training. The results of the study are summarized below.

Effectiveness. In view of the promising results obtained in an earlier experiment the results were a little disappointing. The experimental system based upon the use of teaching-machines was not in fact so successful as the existing, conventional one. Even so, it was by no means ineffective, nor markedly inferior to the normal system. The machine-taught group performed remarkably well; at least up to the standard of the general run of instructor-taught classes, even though excelled by the best of those. The most serious drawback to automated instruction was the generally unfavorable attitude among the students. Unfortunately no identifiable reasons for their attitudes could be found.

Administration and Costs. The initial costs of machines was unduly high but was expected to decrease as production was increased. The problems concerned with an automated system are not insurmountable and could be overcome. The surest generalization possible at that time was that *any* training system is bound to be expensive; a system using teaching-machines should certainly not be more expensive in the long run than a conventional one.

Recommendations.

(1) For shore training in basic educational, technical, and professional subjects, systems of training based upon *combined human and automated* instruction should be planned on as wide a scale as resources would permit. The objective would be to maintain standards while extending the capacity (or increasing the productivity) of instructors.

(2) Although automated instruction alone is unlikely to offer the optimum learning situation, it can undoubtedly produce a notable degree of sustained learning for a majority of personnel. Even without active human participation, but by using only the best programs, produced by experienced programmers, it should frequently be practicable to induce perfectly adequate (even if not the best possible) training results. Particularly when motivation to learn is evident and realistic suitable programs could be developed and machines made available whenever existing instructional facilities are inadequate. Small ships would be an obvious beneficiary from such an application.

(3) Since the quality of programs is the outstanding determinant of how successful such applications can be, the principles and practice of program-writing should be recognized as an important professional activity. It is not a superficial activity which can be accomplished part-time or hastily. It demands an expertise of its own.

U. S. Air Force

An Experiment in Programming the Care and Use of Aircraft Mechanics' Hand Tools[2]

The Air Training Command decided to program a portion of the Jet Engine Mechanic Course given at Amarillo Air Force Base. The portion to be programmed was instruction in the care and use of common hand tools which included nomenclature, physical characteristics, care and application of hand tools such as pliers, screwdrivers, sockets, thickness gauges, torque handles, etc. Training also included practical experience in using about 50% of the

[2]Lewis L. Coleman, "An Experiment in Programming the Care and Use of Aircraft Mechanics' Hand Tools," Trends in Programmed Instruction (Washington, D. C. : National Education Association, 1964), PP. 136-137.

tools by performance of simple mechanical tasks on a jet engine.

A three hundred and two frame linear type program was developed with the following stated objective:

> ...The student will be able to care for and use the hand tools commonly used by a jet engine mechanic.

To provide practical experience for the students in selecting and using tools, eight identical trainers were designed to be used in conjunction with the program. Throughout the package there were frames directing the student to select and use tools to accomplish simple tasks provided by the trainers.

Evaluation of the experiment was accomplished by comparing results of written and performance tests administered to a control group of fifty-two students receiving conventional instruction and an experimental group of fifty-two trained by the program. Students participating in the evaluation project were regular input airmen having an age range of seventeen to twenty-two years and an average education of eleven years.

The two groups were carefully matched by selection on the basis of mechanical and general aptitude scores, and by educational level. The matching of the two groups was within 99.8% accuracy.

The Jet Engine Mechanic Course has a weekly student entry which necessitated the use of seven classes to provide a total of one hundred and four students. As each class entered training, it was divided to form the control and experimental grouping with approximately eight students in each group. During the period of seven weeks the control groups were taught in the conventional manner. Each class had a different instructor.

The programmed instruction experimental groups of approximately eight men each were trained in a separate area. Each week a monitor was assigned

to the experimental group to provide each student with a programmed text, a trainer and a tool kit. The monitor also maintained a record of the time required for each student to complete the program. The students were given no assistance in using the program.

There were two tests used in the evaluation, a fifty question written test containing verbal conceptual items and a performance test covering skill in using tools.

The two tests were used as a pre-test one day before training, as a post-test one day after training and again for retention after thirty days. The two tests were administered by two instructors and two clerks who were associated with neither the conventional instruction nor the programmed package. During testing all students from both groups were intermixed so that the examiner did not know to which group the students had been assigned.

On the written pre-test the control group averaged 32.5% as compared to 32.7% for the experimental group. On the post-test, however, the control group averaged 63%, a gain of 93.9%, as compared to the experimental group which attained 84.2%, a gain of 157.7%.

The performance test showed smaller differences between the groups. The control group averaged 61% on the pre-test and 82% on the post-test, a gain of 32.2%. The experimental group averaged 59.2% on the pre-test and 86.8% on the post-test, a gain of 46.4%.

Both groups were tested again thirty days after training to determine retention. The results were not considered valid because hand tools had been used repeatedly during the thirty day interval.

The time required to teach "Hand Tools" by the conventional method is five hours and ten minutes. The average time to complete the programmed

package was three hours and five minutes. The time saved was about 30%.

After completion of the experiment the package was revised and further testing showed that almost nine out of ten students reached over 91% of the training objectives.

From the experiment it was concluded that the programmed package can teach knowledge items more effectively than conventional instruction methods and can also accomplish the instructions in less time.

The package is now a standard part of instruction in the Jet Engine Mechanic Course of the Air Training Command.

U. S. NAVY

A Study in the Application of Teaching Machines[3]

In order to provide answers as to the appropriatness of implementing the teaching of particular course material in naval classes through programmed instruction, a study was conducted at a naval electronics school. It was decided that the following subjects as taught at the Service School Command, U. S. Naval Training Center, Great Lakes, Illinois, should be programmed:

(1) D.C. and A.C. Electricity These are the basic courses.

(2) Refresher Mathematics

(3) Calculus for Electronics This is part of the computers basic course as taught in the class "C" school.

The four programs developed (D.C. Electricity, A.C. Electricity, Calculus, and Refresher Mathematics) were prepared by subject-matter experts and programmers supplied by a contractor. In preparing the programmed courses,

[3] L. E. Homme, Robert E. Willey, W. H. McMahan, A Study in the Applications of Teaching Machines (Port Washington, N. Y. : U. S. Naval Training Device Center, 1962), PP. 1-5.

use was made of naval textbooks currently being used. Prevalidation work was done on all programs using usbjects comparable in intelligence and age to those students for whom the courses were being prepared. In addition, for the D.C. Electricity Program it was possible to pre-test on a large group of subjects comparable to naval recruits in an actual field (classroom) situation. Because of time limitations this field pre-testing was not possible for the other programs. However, all programs were so constructed that final revision would yeild no more than five percent error.

During the period from 31 July 1961 to 22 September 1961, three experiments in programmed learning were performed. The student groups involved for IA and IB consisted of one hundred and twenty enlisted personnel who had been selected by standard naval procedures without regard to the experiments. Experiment II consisted of thirteen enlisted and one officer assigned to the Electronic Technician class "C" School.

All three experiments dealt with the use of programmed learning in two instructional situations. One experimental situation (experiment IA and IB) compared the effectiveness of programmed learning (use of a teaching machine or a programmed textbook) with the effectiveness of closed-circuit television instruction and that of a "live" instructor.

The second situation (Experiment II) compared methods of homework preparation in an attempt to determine whether it was more effective to use regular homework assignments or homework assignments prepared by using a programmed text.

Experiment IA was carried out among classes being taught an introductory course in D. C. Electricity. In Experiment IB the students were being taught an introductory course in A.C. Electricity. The students in Experiment II

were being taught a course in Basics of Computers of which Calculus is approximately one-half of the course. Because of time limitations the Refresher Mathematics was not taught.

During the experiments a research psychologist was assigned to the Naval Training Center. In this capacity he was responsible for distribution of the courses to the students, for explaining the use of the teaching machines and programmed textbooks, for collection and construction of evaluation data, and for coordination of the experiments with the school's instructional staff.

The results of the experiment indicated that:

(1) The use of programmed learning methods is essentially as effective as conventional methods of instruction, such as classroom lecture, either by closed circuit television or by live instruction, for teaching D.C. and A.C. electricity.

(2) D.C. and A.C. electricity can be taught in considerably less time by programmed textbooks than by conventional methods and in about the same time by a teaching machine as by conventional methods.

(3) A homework assignment in a program format is more effective than conventional homework assignments.

U. S. NAVY

Programmed Instruction in
Basic Electricity[4]

Programmed courses in basic electricity and mathematics were developed under a contract with the U. S. Naval Training Device Center[5] and were given

[4] L. S. Standlee, E. A. Hooprich, J. LaGaipa, Programmed Instruction in Basic Electricity, (San Diego, California : U. S. Naval Personnel Research Activity, 1963), PP. 1-6.

[5] L. E. Homme, R. E. Willey, W. J. McMahan, A Study in the Applications of Teaching Machines, (Port Washington, New York : U. S. Naval Training Device Center, 1962), PP. 1-19.

a preliminary tryout at the U. S. Naval Training Center, Great Lakes, Illinois. Parts of the basic electricity course were revised at the U. S. Naval Personnel Research Activity, Washington, D. C. for use in this experiment.

The purpose of this experiment was to determine the effectiveness of these revised programmed materials for teaching basic electricity and, further, to determine whether their effectiveness, relative to conventional instructions, might be influenced by either of two factors - ability of instructor or difficulty of subject matter.

The subjects of the experiment were one hundred and fifty-five sonarmen in eight classes of the Basic Sonarman (Surface) Course, Fleet Sonar School, Key West, Florida. Subjects in different experimental groups were matched statistically in terms of GCT, ARI, MECH, CLER, and Reading Comprehension test scores. The experimental groups also had equal educational backgrounds -- twelve years.

Each of the eight classes was taught D.C. electricity for one day of the third week and A.C. electricity for two days of the fifth week of the Sonarman course. Each of the classes began one week apart.

Subject matter difficulty was judged to be represented by the D.C.--A.C. variable, with D.C. being relatively easy and A.C. being relatively difficult subject matter for Sonarmen to learn.

The instructional method consisted of either programmed or conventional classroom instruction. Under the programmed method students worked on programmed booklets. Instructors answered students' questions but avoided giving lengthy explanation. Under the conventional method instructors gave their usual classroom lecture and demonstration. The classroom time was the same for both methods of instruction.

The ability of the instructor was determined by supervisory ratings, and of the available instructors, those rated the highest and the lowest on general instructional ability were used to teach the classes.

As a result of the experiment the following conclusions were reached:

(1) No one method of instruction, ability level of instructors, or difficulty level of subject matter was found consistently to yield superior student achievement. Nor were there consistent intraction effects. Over all, though, there was a tendency for students to achieve slightly more under the programmed method of instruction.

(2) Students' attitudes were more favorable toward the programmed method of instruction when the subject matter was relatively easy (D.C.) than when the subject matter was difficult (A.C.). Instructors attitudes toward programmed instruction tended to be negative.

(3) Though the programmed method of instruction tended to be slightly superior in terms of objective tests of student achievement both the instructors and students thought that programmed materials should be used to supplement rather than replace conventional methods of instruction.

U. S. ARMY:

Programmed Instruction and Low

Altitude Aerial Observation[6]

An experimental training course in low altitude aerial observation was developed for classroom instruction in an earlier study, Subtask OBSERVE I, by the U. S. Army Aviation Human Research Unit. The course had been incorporated in the Army training program in FM 1-80, Aerial Observer Training.

[6] Peter B. Dawkins, Programmed Instruction and Low Altitude Observation, (Washington, D.C. : George Washington University, Human Resources Research Office, 1964), PP. 1-13.

However, aerial observer training must sometimes be given in field situations where classroom instruction is impractical. Automated or programmed teaching methods, which provide a high level of course standardization and do not require experienced instructors or classroom space, seemed to provide a possible answer to field training needs. The objective of this study was to prepare, administer, and evaluate an automated mode of presentation of training material for low altitude aerial observer.

Programming techniques were applied to the verbal and visual (Photographs and maps) material developed in the initial experimental training course. A series of programmed texts was designed to teach both knowledge and skill in the four basic content areas of low altitude observation: Visual Search, Target Recognition, Geographic Orientation, and Target Location.

Subjects in this study were twenty-eight non-commissioned officers from various organizations at Fort Rucker, Alabama who were assigned in support of OBSERVE II Research. These subjects had considerable and varied Army experience. A selection requirement was that no subject should have an Army General Technical (AGT)[7] score below 110. The average AGT score was 120.1, and the range was from 110 to 141. The AGT selection requirement used in this study was imposed solely to make the trainees more comparable to those used in the earlier study, OBSERVE I, in terms of general intellectual ability. No implication was intended that a minimum AGT of 110 is required to be an aerial observer.

The programmed texts were administered to the experimental group to determine whether programmed methods provide as efficient means of teaching the basic

[7]As this test is composed of a Verbal and a Numerical subtest, it can be considered as a measure of intelligence or academic potential. It has a mean of 100 and a standard deviation of 20.

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aerial observation skills. A criterion test was administered before and after the programmed instruction to measure the degree of learning. To separate learning gains that stemmed from taking the first criterion test from learning gains resulting from experience with the programmed course, a control group was tested twice but was not given intervening instruction.

The following is a summary of the study results:

(1) Students trained by the programmed course made substantial gains in accuracy of target location.

(2) Students were able to study and learn with minimal direction from the course administrator.

(3) Differences in intellectual ability, as measured by the Army General Technical aptitude area scores, were not related to differences in study speed for the ability range included in the study.

(4) Intellectual ability was positively related to learning improvement in target location speed and accuracy.

(5) Average time for the programmed course (15 hours) was less than the standard required by conventional classroom instruction. Study time for individual students ranged between nine and twenty-two hours.

(6) The learning gains by students taking the programmed course were similar to the gains in the earlier studies with students who received OBSERVE I classroom observer training.

From the above results the following conclusions were drawn:

(1) Programmed texts can teach the four basic skills of low altitude aerial observation as effectively as conventional classroom methods and, consequently, can be used as an alternative method of instruction.[8]

[8]The programmed texts have been scheduled for publication as official Army literature.

(2) Instruction in field locations is practical with programmed tests, since a high level of standardized instructions is consistently maintained for all students while, at the same time, the need for a skilled instructor is eliminated.

The experimental studies have presented programmed instruction and learning in a military environment. These studies and many others have shown that automated teaching is just as effective in many cases and superior in others, to conventional classroom instruction. More important they recognize, either explicitly in the case of the Royal Navy or implicity with the others, the absolute necessity of high quality programs prepared by experts in the field. Further, they show that we do not know enough about automated instruction to apply it effectively across the whole spectrum of military or naval training. But, we do know enoughto use it effectively in a large number of training situations and can by further research and study expand to eventually cover the whole field of subject matter.

## CHAPTER IV

## SUMMARY AND CONCLUSIONS

### Summary

An historical and critical study of automated instruction indicates that a combination of circumstances favored its rapid growth and wide spread acceptance. First of these was the pressing need for more and better teachers. Second was an increased emphasis on scientific curricula. Third was the ever increasing demand for more school space to accommodate the expanding school population. The success of experimenters using carefully prepared programs led many people to believe that automated instruction was a panacea for educational needs. Spurred on by the vision of profits, commercial interests embarked upon a large scale effort to market automated instruction. It is believed that the use of this instructional method was, in most cases, premature. While the devices for automated instruction met all the criteria for learning and had been thoroughly tested under carefully controlled conditions the experimentation with programs was not nearly so thorough. Further, not enough study had been given to the characteristics of the learner and the effect that these differences would have on the success of automated instruction. Failure to consider in detail these two variables led to many failures with automated instruction and gave rise to much skepticism as to the ultimate worth of this mode of formal instruction.

At the same time the civilian educators became entranced with automated instruction the Army and Air Force began to experiment with its use in all phases of training. The Navy, however, was very cautious in its approach and considered its use only in critical areas of training such as electronics. The Army-Air Force approach of broad use gave these two services invaluable

experience in the use of automated instruction and pointed to those areas where the state of the art was sufficiently advanced to permit productive use and those areas where it was not. The restricted approach of the Navy, on the other hand, led to disenchantment with the system as a whole when automated instruction did not measure up to expectations. This led to an official policy that, while automated instruction was "here to stay", it has little value to the Navy except in a limited sense.

## Conclusions

An examination of the literature and many studies on the use of automated instruction has led to the following conclusions:

(1) The state of the art has advanced to the point that in areas of relatively simple subject matter it is a useful and productive tool. In the areas of more difficult subject matter the program must be increasingly appropriate for <u>each</u> student. Unless due consideration is given to student differences in abilities, educational experiences, study habits, attitudes, etc., there is little chance that a program will be an outstanding instructional tool. At the same time, the preparation of a hundred or more different versions of the same program is, at the present time, neither feasible nor desirable. The solution must lie between the extremes of preparing one standard program to fit all students and preparing hundreds of unique programs. Much research and study will be necessary to gain a better understanding of how students differ when they learn before the art of programming can successfully advance to the point that automated instruction will be a truly useful tool across the broad spectrum of naval training.

(2) To date the Navy has had very limited success in the use of

automated instruction primarily because of the area of application. The art has simply not advanced to the point that sophisticated training can successfully be administered by this method.

(3) The opportunities for productive application of automated instruction are many. Studies completed by the Army and Air Force and actual practice have proven that many relatively simple tasks can be taught by automated instructional methods. There are many uses for teaching such tasks in Machinist Mates School, Boiler Tender School, Gunners Mates School, etc., uses which would speed the training process and reduce the long range costs of training.

Successful efforts using automated instruction to teach subjects primarily concerned with factual knowledge rather than concepts suggests that programmed texts could be used on board ship. Many naval personnel are prevented from attending service schools because they do not possess the necessary mathematical background. Further, many must complete a course in high school algebra before they can quality for a high school diploma which they failed to get when they "dropped out" of school to join the Navy. A carefully designed programmed text could meet both these needs. The Navy must provide its personnel the means to advance themselves educationally and automated instruction provides the most efficient means to accomplish this goal in a shipboard environment when teachers are not available.

(4) Experimenting with automated instruction can be a costly process but maintaining an efficient training system is expensive anytime and will be more expensive in the future. Potentially automated instruction can contribute to a more efficient and less costly training system but expanded experimentation and use is necessary to determine the best teaching technology

and programming techniques for use in the naval training environment. To gain this knowledge the Navy must be willing to invest a considerable sum for research now. To do anything less will put the Navy in the position of being "on the outside looking in" in the field of military training.

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